SIESTA and its free boundary development

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Magnetohydrodynamic (MHD) analysis is very important when designing and evaluating magnetic confinement devices. *SIESTA* [1] allows the self-consistent calculation of the MHD equilibrium of any three-dimensional machine, allowing the development of magnetic islands and stochastic regions. *SIESTA* relies on a smart preconditioning scheme combined with the use of the solution that the *VMEC* code finds for the same problem, which makes it much faster in comparison to similar 3-D codes. *SIESTA* was originally conceived as a fixed-boundary code, which limits its application to problems contained in the confined region of the plasma. In this work we present the ongoing efforts to make of *SIESTA* a free-boundary code and have access to information of the magnetic topology between the plasma and the vacuum vessel.

Tests are currently being done on the OP1.1 W7-X configuration, which is well documented. Nevertheless the motivation to start this study came from a configuration with the presence of bootstrap currents [2], which show a considerable influence on the divertor island structure — it is displaced towards the confined plasma. For cases similar to this one, self-consistent MHD studies are of utmost importance to have a reliable knowledge of the magnetohydrodynamics taking place in the experiment.

The approach followed consists of expanding the *VMEC* solution all the way to the vacuum vessel, which becomes the new fixed boundary. In this way, the fixed-boundary *SIESTA* can still be used to iterate towards equilibrium while allowing for the distortion of the LCFS. Using *SIESTA* in this way requires the artificial extension of the coordinate system provided by *VMEC* all the way to the new fixed boundary. In order to provide *SIESTA* with a good initial guess for the magnetic field over the outer region, the IPP *EXTENDER* code [3] has been used. *EXTENDER* is based on the virtual casing principle [3–5] to calculate the magnetic field created by the plasma currents calculated by *VMEC*, to which the contribution of the external coils is then added.

References

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